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SNAP BEANS

**for marketing
canning
and freezing**



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SNAP BEANS, a native American vegetable, are grown extensively in home gardens, for marketing fresh, and for canning and freezing. About 170,000 acres for marketing fresh and about 55,000 acres for processing have been grown annually in recent years. Florida, California, Louisiana, Texas, and the Carolinas are the leading producers of market beans, while Maryland, Oregon, New York, Wisconsin, and Michigan are the leading producers for processing.

Beans are grown in every State and are very widely adapted, but in general very heavy soils, as well as strongly acid or strongly alkaline soils, should be avoided.

Hundreds of varieties are available, but most of the acreage is taken up with a few varieties. In the South more than half the acreage is in Stringless Black Valentine. In the northern canning areas much of the acreage is in Stringless Green Refugee types and Brittle Wax, while in the western United States a pole bean known as Blue Lake is dominant for canning and freezing. Dozens of varieties are used in home gardens, but perhaps the most popular is the pole variety Kentucky Wonder.

Market preferences for specific varieties both as fresh beans and as a canned product are quite pronounced, since there are marked differences in color, quality, size, and shape among varieties. Market trends for all purposes are for round or nearly round beans with very dark green pods and a small amount of side-wall fiber.

Information is given on cultural and marketing practices, diseases, and insect control.

SNAP BEANS FOR MARKETING, CANNING, AND FREEZING

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IMPORTANCE OF THE CROP

SNAP BEANS are one of the most popular vegetables known to have originated in the Americas. They have been very common vegetables in our gardens for several hundred years, but, with the expansion of the market-gardening, canning, and freezing industries during the last 20 years, vast changes have occurred in varieties, geographical distribution, and cultural practices. The recent annual acreage of snap beans in market gardens has been about 170,000 acres and the acreage of those for canning and freezing about 55,000 acres. It is almost impossible to determine the amount of space devoted to these beans in home gardens and in market garden areas adjacent to large cities.

ADAPTATION

Beans are sensitive either to an alkaline or to a very acid condition of the soil. In general they thrive better on mildly or moderately acid soils than on neutral or alkaline soils. If the soil is very acid the acidity can be corrected by applying lime, but careful precautions should be taken to avoid overliming. Too much lime may be quite as bad as too little, since too much may result in a deficiency of other metals, such as iron and manganese. In correcting an extremely acid condition, an effort should be made to leave the soil mildly acid rather than neutral or alkaline. Since there is no generally very practicable way of reducing alkalinity, strongly alkaline soils should not be planted to snap beans. About 300 pounds of sulfur per acre has been found satisfactory in the southeastern coastal areas for correcting overliming and an associated manganese deficiency.

Both light and heavy soils are used for the production of snap beans, but it is generally conceded that very heavy soils are not favorable for their growth. If a very light soil is used, it is essential to supply plenty of fertilizer.

Bean plants may drop their blossoms or pods during excessively hot or rainy weather. Varieties differ greatly in their sensitivity to weather conditions; so in many places growers find that they must determine by trial which varieties are best adapted to local conditions.

The States having the greatest acreage devoted to the production of snap beans for canning and freezing are Maryland, New York, Wisconsin, Michigan, Indiana, Pennsylvania, Arkansas, Mississippi, Tennessee, Louisiana, Delaware, and Colorado. Oregon ranks high in production, despite a relatively small acreage, because of high yields per acre. For market-garden beans Florida is the leading State, but California, Louisiana, Texas, North Carolina, South Carolina, Virginia, Georgia, New York, New Jersey, Maryland, Mississippi, Pennsylvania, Colorado, and other States ship large quantities to established markets. Nearly every large city is at least partially supplied with market-garden beans by short-distance hauls at some time during the summer season.

VARIETIES

DESCRIPTION

Most of the best-known American varieties of snap beans have been introduced since 1890. This rather recent introduction is due in part at least to the interest in early, stringless beans with green pods. N. B. Keeney produced the first conspicuously successful bean of this type, which was introduced in 1894 as Burpee Stringless Green Pod. Most of the varieties introduced since then have been stringless. Many old favorites of the stringy type are still in use, but their popularity is steadily decreasing.

Owing to the cost of handling pole beans, varieties of this type are seldom grown to any great extent except in home gardens and in a few canning areas in the western United States where the extra cost of handling is more than offset by the yield and price.

Snap beans occur in two natural classes, wax-podded and green-podded, of which the latter is vastly more important. Pods of wax beans show mechanical injuries and disease lesions very plainly; and so they have been discriminated against to some extent by both growers and consumers, but there is usually a good market for wax beans if they can be grown satisfactorily.

In the stringless, green-podded bush class the most popular variety for shipping is Stringless Black Valentine (fig. 1). This variety has become so popular that many seedsmen no longer carry the old stringy strain of Black Valentine. The pods of Stringless Black Valentine are usually described as oval in cross section, although they vary from a flat to fat oval, with location on the plant, with season, and with stage of development. This great variation in pod shape has induced some seedsmen to attempt to select or produce from crosses a strain of Stringless Black Valentine having almost round pods. Reports from some sections indicate that the new round-podded strains of Stringless Black Valentine do not yield so heavily as those with the oval type of pod, but growers in other areas consider them satisfactory.

In many localities Bountiful, only a few years ago the most popular of the stringless, green-podded bush group, outyields Stringless Black Valentine, but its flat, light-green pods now sell at a discount on most

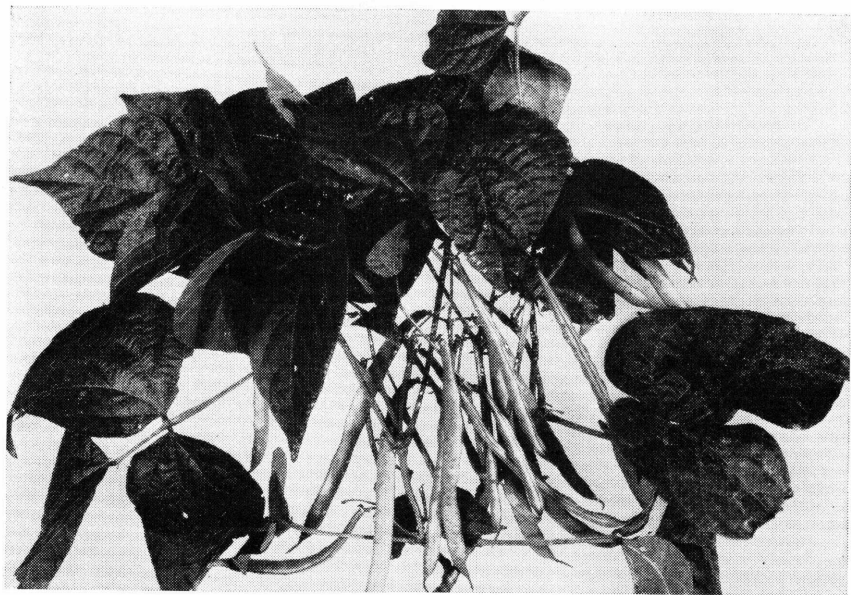


FIGURE 1.—Stringless Black Valentine bean with six leaves removed to show podding habit.

markets. Plentiful is a new flat-podded variety, which in some areas and seasons gives even higher yields than Bountiful but which under other conditions may yield much less. The pods of Plentiful average slightly larger and slightly darker green than those of Bountiful.

The varieties so far discussed are stringless, but there is so much side-wall fiber in them that to produce a satisfactory product pods should be picked before they reach full size.

In the round-podded subclass of the stringless, green-podded bush beans Tendergreen (New Stringless Green Pod) is the most popular. Full Measure, which resembles Tendergreen rather closely, is popular in some places, but elsewhere it does not yield so well as Tendergreen. These two varieties have very dark green pods.

Giant Stringless Green Pod, despite its large, light-green, round pod, is somewhat popular for canning as cut beans, but its popularity is declining. Burpee Stringless Green Pod, somewhat similar to Giant Stringless Green Pod, has been largely replaced by a selection from it, known as Landreth strain of Burpee Stringless Green Pod. This variety remains fairly popular with home gardeners.

Stringless Black Valentine, Bountiful, and Plentiful are rarely used for canning or quick freezing, but Tendergreen, Full Measure, Giant Stringless Green Pod, and Burpee Stringless Green Pod are used not only for marketing but also for canning and freezing. Under southern conditions the first three varieties tend to outyield the round-podded varieties, but in many parts of the country the yield of the better quality beans is satisfactory.

Stringless Green Refugee is a semi-indeterminate bush variety of the highest quality for canning, but its susceptibility to mosaic and its light yields in unfavorable weather have resulted in a decline in its use during the last few years. It is about 2 weeks later than Tender-

green and has long, straight, light-green pods of mild flavor and very little fiber. It is little used as a shipping and home-garden bean but is used extensively as a high-quality canning bean.

U. S. No. 5 Refugee is a mosaic-resistant variety about a week earlier in season than Stringless Green Refugee. Idaho Refugee is a mosaic-resistant variety only a day or so later than U. S. No. 5 Refugee. These two varieties are resistant to common bean mosaic but not to yellow bean mosaic, a disease of minor importance. Part of the Idaho Refugee plants are variegated (sometimes erroneously described as diseased); under some conditions these variegated plants appear to yield as well as the normal green plants. There are also minor differences, such as seed color, light greenness of pod, straightness, and color splashing on the pods, between these two varieties. These varieties appear to be gradually replacing Stringless Refugee in New York and other areas. Under southern conditions U. S. No. 5 Refugee has been found to be very hardy and productive and to set pods during the summer, when Stringless Black Valentine and other commonly grown varieties are unproductive. U. S. No. 5 Refugee appears to be of value in some places in the South as a hardy, home-garden bean or for local markets when other familiar varieties cannot be profitably grown.

The pole variety White Creaseback includes a number of similar strains differing somewhat in pod size, season of maturity, and use. In general they are late beans, in season with Refugees. In the western United States strains of this variety called Blue Lake are extensively grown for canning and freezing. Many are packed "asparagus style," and the quality and appearance have resulted in good prices for the produce. However, the variety is stringy when the pods are older, or at younger stages if grown under adverse conditions. The pods are dark green, relatively free from fiber, and fat oval, approaching round, in cross section. Extensive use is also made of this variety for quick freezing. In the South strains with larger pods, slightly rough in later stages, are grown for home and market use. In the West on almost all the acreage this variety is grown for canning and freezing as an irrigated pole bean, but for seed it is not poled on account of the cost. The yields of White Creaseback under western conditions are usually very heavy; many farmers in Oregon average 7 to 8 tons per acre of canning beans. Some seedsmen have developed stringless strains of Blue Lake by selections from crosses with U. S. No. 3 (Rust-resistant White-seeded Kentucky Wonder), but these have yet to demonstrate their value.

Kentucky Wonder, known under various synonyms, is the most widely grown of the large-podded, late pole varieties. Some lines are stringless when young but develop decided strings later. Others are stringless throughout the marketable stage. The pods are very long (6 to 10 inches), rough, fairly thick, and wide, almost round at maturity. The Kentucky Wonders are mostly used as home and market-garden beans. Varieties similar to Kentucky Wonder, which is also frequently called White-seeded Kentucky Wonder, such as Burger Stringless, McCaslan, and various rust-resistant strains of similar type, are also grown for home and market-garden use. So-called bush types of Kentucky Wonder have been introduced but have as yet attained no popularity.

Ideal Market is increasing in importance as a fairly early pole bean for the southern United States. The pods are long, round, slender, and dark green, and stringless when young, but they have very strong strings later. The quality of this variety is very good.

Wax-podded beans are rarely grown in the South for home-garden use but are grown rather extensively for shipping. Almost any flat-podded wax variety may be sold on the market as Bountiful Wax, but the two varieties that are most frequently sold under this misleading name are Webber Wax and Sure Crop Wax (fig. 2). These two varieties are early and productive. Webber Wax is almost stringless, and Sure Crop Wax is stringless. Sure Crop Wax has gradually replaced Currie Rust Proof Wax. Davis White Wax is in season with Sure Crop Wax, and the pods are much finer in appearance in spite of their stringiness and lack of quality. Consumer preference, even in wax beans, seems to be distinctly away from flat-podded beans.

Hodson Wax is a popular late, flat-podded wax bean. It is grown extensively in Florida and in other market-garden sections. Stringy



FIGURE 2.—Sure Crop Wax bean with six leaves removed to show podding habit.

and tough, but striking in appearance, it is used only as a shipping bean.

Among the stringless round-podded wax beans, Brittle Wax (Round Pod Kidney Wax) is used most for canning, both as cut bean and whole pack. It is gaining in popularity for shipping and home gardens. In season it is the same as Sure Crop Wax. The most important objection to Brittle Wax is that it usually does not yield well under adverse conditions. Improved Kidney Wax is similar to Brittle Wax, but it is more prolific; and its pods are not quite so round or so free of fiber.

Pencil Pod Black Wax is of very high quality, but the black seeds and curvature of the pods have caused it to lose favor as a canning bean. It is still grown for home and market. In some areas its yields are high in comparison with those of other varieties, but in general in the South they are low.

Determination of the best variety to use is mainly a local problem best settled by finding what varieties are known to succeed locally. In the case of growers who produce beans for market or canning, it is sometimes not so much a question of what varieties will do well as of what varieties can be sold.

Unlike many other crops, most of the varieties of beans can be and are frequently used for dual or even triple purposes. In some cases market-garden growers plant a larger acreage than they really hope to dispose of as market-garden beans with the expectation of selling the surplus to canning factories. In such cases the canners determine the variety or varieties that will be offered on the local market as a fresh vegetable.

VARIETAL TRENDS

Increase in sales of dark-green, quick-frozen beans has perhaps been one of the most important reasons why both canners and market gardeners are now demanding round-podded, dark-green beans with a minimum of fiber. Tendergreen has increased rapidly in favor during the last 10 years at the expense of Burpee Stringless Green Pod, Giant Stringless Green Pod, Full Measure, Stringless Black Valentine, and Bountiful. If a dark-green bean similar to Tendergreen but more productive under adverse conditions could be produced it would probably tend to replace all these varieties.

The quality of all the Refugee varieties of beans is unquestioned, but apparently consumers are finding the dark-green pods of Blue Lake more attractive; so many Refugee canners are demanding a mosaic-resistant Refugee with pods of the color of those of Blue Lake.

Seed colors are a matter of conflicting opinions in many cases. Market gardeners seem to prefer seed colors other than black so that they can tell by inspection whether the seed has been held from one planting season to another. But seedsmen seem to prefer black seed, since there is no noticeable change in color with age, and if the seed is properly stored there is little or no loss in vigor or germinating percentage in 1 year. Since the relatively spectacular success of the white-seeded Blue Lake, canners have been demanding a white-seeded Refugee. The probable reason for this is that in cut beans of Brittle Wax, which has a deeply colored eye, of Giant Stringless Green Pod, and in a few cases of Refugee there has been a slight but noticeable coloration of the seed, and improperly processed Full

Measure has yielded a discolored liquor. As canning beans are now grown in seed-growing areas of the West it is easy enough to separate white-seeded field beans from canning varieties. If white-seeded canning varieties were produced, the consequences of failure to keep them separate might be rather costly. Perhaps varieties the seed of which have very small, dot eyes, or those in which the color of the seed does not develop until the beans are nearly mature, may be the answer to this problem.

Brittle Wax is an excellent-quality bean, but many canners who are growing it would like to see an improvement in hardness and yield and an increase in the intensity of the yellow color in the pods. There has also been some inquiry about a wax-podded Blue Lake for use in the western areas.

The introduction of stringless varieties has been the cause of much of the great increase that has occurred in the bean-canning industry within the last 20 years; and the insistence of the canning industry upon certain snap bean characters has resulted in a great stimulus to bean breeding.

SEASON OF MATURITY

In the descriptions of varieties no mention is made of the number of days to maturity, i. e., to marketable size. This is due to the fact that maturity varies considerably from one locality to another and from one season to the next. Ordinarily, a grower would expect to be able to pick pods from a plant within 2 weeks of the appearance of bloom; yet, in extremely hot weather if there is a scarcity of available moisture during the flowering period, many sets of blossoms may drop off, and it may require as much as 6 weeks from the first bloom to the edible stage. On the other hand, cool weather may result in delayed development of pods that have already been set. Early varieties such as Stringless Black Valentine and Brittle Wax reach a marketable size in 50 to 55 days after planting under a wide range of conditions in Colorado, New York, and South Carolina, while Stringless Green Refugee is about 2 weeks later. Pods are usually ready for harvest within 2 weeks of first bloom.

PLANTING AND CARE

ROTATION

The frequency with which beans occur in the rotation is at least somewhat dependent on the occurrence of soil-borne diseases. Where root rots and other diseases do not give much trouble, beans may safely be planted in 2 years of a 5-year rotation. Where root rots are troublesome, beans should not be planted on the same soil more than once in 5 years.

FERTILIZATION

Contrary to some popular notions, beans do well on fertile soils. Since the bean plant lives for only a relatively short time, it is preferable to supply fertilizers that are quickly available. A moderate application of a complete fertilizer, such as one analyzing 5 percent nitrogen, 10 percent phosphoric acid, and 5 percent potash, is usually of some benefit, but it is best to follow fertilization practices that are

based on the known actual requirements of the soil. The precaution that is really necessary in planning fertilization of beans is to make sure that an excessive amount of nitrogen is not supplied. When too much nitrogen is supplied, the vine growth may be heavy, but the yield of pods may be disappointing. In some southern areas where leaching occurs readily on very light soils it may be necessary to make one or more side dressings of a nitrogenous fertilizer. The complete fertilizer should be put into the soil approximately 2 weeks before planting the seed in order to avoid fertilizer injury. Applications of fertilizer in bands, $1\frac{1}{2}$ to 2 inches to the side of the seed and $1\frac{1}{2}$ inches below it, are recommended for Virginia and South Carolina if the equipment is available. In New York, Florida, Louisiana, Massachusetts, and West Virginia also good results have been obtained with band placement.

INOCULATION

In some cases legume inoculation may materially decrease stands, especially if seeds are moistened in any way at planting time. Because of increased cracking in the drills when beans are planted with the so-called dry types of inoculum, stands may be slightly decreased if this material is used. Where inoculation is necessary it is recommended that it be used even if somewhat reduced stands are obtained. In general, inoculum will be needed on soils that have not been planted to beans previously. In using inoculum, the grower should follow the directions supplied with it.

SEEDBED PREPARATION

The seedbed should always be well prepared and free from clods; otherwise, many of the young plants will die before they are able to push their way through the clods. In case of rains, which may result in a crust forming on some soils before the plants are up, it may be necessary to break the crust to secure a fair stand. Although bean plants have a fairly extensive root system, they do not appear to be gross feeders and hence are unable to compete successfully for their share of soil nutrients on spring-plowed sod. If beans are to follow a sod crop, the field should always be fall-plowed. Beans in the rotation should preferably follow some cultivated crop with a more vigorous root system.

In areas of heavy rainfall beans are usually planted on raised beds in order to secure adequate drainage. In areas where row irrigation is practiced the necessary construction of water furrows results in a slight ridging of the soil at the base of the plants. In areas of moderate rainfall and in those where overhead irrigation is used, raised beds or ridges are rarely used. In dry-land areas, listing, the opposite of ridging, may be necessary.

TIME OF PLANTING

Since beans are very sensitive to cold weather, it is essential to plant them only after the soil has become fairly warm in the spring, preferably after danger of frost is past. In the South it is also necessary to plant at such a time that the nonhardy varieties will not be caught by either too hot or too cold weather at podding time.

RATE OF PLANTING

Planting rates vary from 15 to 240 pounds per acre, depending on germination of seed and locality of planting, and to some extent on variety. In general, western and northern growers plant less seed than southern. In the canning areas of Wisconsin and in the canning and market-garden areas of Colorado, 20 to 30 pounds per acre is considered sufficient; but in Florida, planting of market-garden beans at 60 to 180 pounds per acre is general. In South Carolina, 60 to 75 pounds per acre is recommended. The ability of bean seed to germinate is lost very quickly if it is stored under hot, humid conditions. Many southern growers are able to reduce the rate of planting by having the seed shipped in by express as needed or by having it held in air-conditioned storage before planting. Where rains are generally expected at planting time it is a common practice to increase the rate of seeding, since rain within 48 hours after planting usually interferes, to some extent, with germination. When good germination is obtained, the very high rates of seeding may actually reduce the yield per acre, and they always reduce the yield per plant. Up to about 125 pounds of seed per acre will probably increase the total yield per acre over a 40- to 65-pound rate at some places in the South, but the increase in yield may not be worth the cost of the extra seed. Even in the South varieties such as U. S. No. 5 Refugee fall off rapidly in yield when the seeding rate is more than 30 pounds per acre.

DEPTH OF PLANTING

Depth of planting should vary with type of soil, temperature, and amount of moisture available. Beans are ordinarily planted rather shallow, $\frac{1}{2}$ to $\frac{3}{4}$ inch, on heavy soils and deep, $1\frac{1}{2}$ to 2 inches, on light soils. Under South Carolina conditions on light Coastal Plain soils it has been shown that increased depth of planting up to 2 inches resulted in somewhat better stands than $\frac{1}{2}$ -inch depth but that infection with the dry root rot organism increased with depth of planting. Such infection did not decrease yield under the conditions of the experiment. Beans should be planted deep enough so that they will be in contact with sufficient moisture for uninterrupted germination. To obtain sufficient moisture in some cases, it may be necessary to furrow out to a depth of 4 to 6 inches but to cover to a depth not exceeding 2 inches, depending upon soil type and temperature.

SPACING OF ROWS AND CULTIVATION

Distances between rows vary from 28 to 48 inches. The shorter distances are common in irrigated regions, and those from 36 to 48 inches in regions that depend upon rainfall.

Beans should be kept free from weeds; however, more than three or four cultivations are usually unnecessary, and in some places only two may be required. Cultivations should be shallow and should be discontinued before the plants become large enough to be injured by the process. In the South, where beans are planted on fairly high beds, it is the custom to follow cultivation with a sweep 14 to 18 inches wide to move the soil up close to the base of the plants and to help maintain the beds, which may undergo considerable washing down by heavy rains.

IRRIGATION

In irrigated areas it is good practice to have the soil sufficiently moist prior to planting so that it is not necessary to irrigate until after the crop is up. Frequency of irrigation is determined largely by the rate of evaporation. Beans should not be permitted to suffer from lack of water to the point where they become dark green in color. When this occurs, the resulting crop usually does not come up to expectations. It is especially desirable to supply plenty of moisture at blooming time, for if this is not done the set of beans is apt to be very limited. If no rainfall occurs, it usually requires from four to six irrigations to bring beans to the marketable stage.

In many irrigated sections it is the practice to irrigate only every other furrow. This practice results in good aeration, since the odd-numbered furrows are used for one irrigation and the even for the next irrigation. It also has advantages at harvesttime, since it is not necessary to wait for the ground to dry out to use machinery.

SIZES, GRADES, AND SHIPPING

In some canning sections it is customary to sell beans on the basis of grades, the small beans for whole pack selling at a premium and overmature pods at a heavy discount. In this way the grower who permits his crop to exceed desirable sizes is penalized. In most sections where cut beans are the main product, selling by grades is a rather uncommon practice. Maine is an exception, since a number of its larger factories have bought on the basis of U. S. Standards for snap beans for canning or freezing for the last few years. Market-garden beans that are shipped to the larger markets are usually sold under grades.

In the South most beans are marketed in bushel hampers, and frequently such a basket is also used as a field container (fig. 3). Many growers instruct their pickers to grade in the field, and the beans are then shipped without any further grading. Usually field grading is not very carefully done, and better prices are received when growers haul beans to a central packing shed for careful grading as they pass over belt conveyors. Deformed, diseased, overmature, broken, and otherwise undesirable pods, as well as leaves, sticks, and other waste materials, are removed during the grading process. Market beans are usually not graded for size unless varietal mixtures of different sizes are involved or beans of the same variety from different parts of the same field show distinct size differences. Varietal mixtures of closely related varieties such as Full Measure and Tendergreen are not usually discounted, but in most cases varietal mixtures sell at a discount. It is especially desirable to avoid mixtures of round with flat-podded or of wax with green-podded beans.

At present flat beans are usually sold for less than round beans of corresponding quality on the same market at the same time. There has been some selling of oval Stringless Black Valentine as a round bean, but there is a tendency to classify it as an oval and sell it as such.

Descriptions of the standards established for the market grades of green or snap beans and of those for canning and freezing can be obtained by writing to the Agricultural Marketing Administration, United States Department of Agriculture, Washington, D. C.



FIGURE 3.—Field-graded Stringless Black Valentine beans being packed for shipment to market in bushel hampers. (Courtesy of the South Carolina Truck Experiment Station, Charleston, S. C.)

DISEASES AND THEIR CONTROL ¹

IMPORTANT DISEASES

Five diseases that attack the leaves, stems, and pods are of considerable importance in most bean-growing areas. Anthracnose is most noticeable on pods in the form of spots or deep cankers that may develop either before or after the pods are picked for market. Bacterial blight is most noticeable on the leaves but later attacks the stems and pods. The diseased leaves first have small water-soaked spots, which rapidly enlarge, turn brown, and are usually surrounded by a yellow area. Coalescence of several spots causes the whole leaf to die and drop off. Frequently all the leaves are destroyed in this manner. On the pods the disease causes water-soaked or greasy spots that become interspersed with flecks of red and frequently exude drops of sirupy liquid containing millions of bacteria. Mosaic causes severe curling and crinkling of leaves and usually makes the plant dwarfed and unproductive. Pods from a diseased plant are apt to be small and poorly shaped. Powdery mildew is first noticeable on the leaves, which become covered with white dust as if they were sprinkled with fine salt. In severe cases a whole field of beans may drop most of their leaves. Rust is first observed on leaves in the form of many spots, usually smaller than a pinhead. These spots are each a tuft of brown powder made of thousands of spores, which are easily spread by wind or rain over wide areas. Severe rust also will cause almost complete defoliation. The spots occur less frequently on pods and stems.

¹ For more complete information on bean diseases, consult U. S. Department of Agriculture Farmers' Bulletin 1692, Bean Diseases and Their Control.

Three other diseases of beans, important under special conditions, are usually associated with wet soils and wet weather, accompanied by excessive warmth or cold. These diseases are: (1) Root rot, which may be of several different types. When roots are severely attacked, the plant is unable to take up solutions from the soil, wilts, and dries up. (2) Stem rot also may be of several types. Stem rot attacks the stem at or above the soil level, causing the plant to wilt or break over, as with root rot. Stem rot is frequently accompanied by a cottony white growth on the lower stem and on the soil near the base of the plant. (3) Web blight is confined mostly to areas of the South where moisture is excessive. The whole plant becomes enmeshed in a growth resembling a spider web, which causes most of the leaves to collapse.

DISEASE AVOIDANCE AND CONTROL

If inoculation of the seed to supply nodule bacteria to the plant is considered necessary, the inoculum should not be applied with water, since seed-borne diseases may become distributed to many of the seeds that would otherwise produce healthy plants. Anthracnose, bacterial blight, and mosaic are seed-borne diseases. Anthracnose and bacterial blight can be avoided usually by using seed grown in certain Western States where these two diseases seldom occur. Mosaic can be prevented ordinarily by using seed from carefully selected mosaic-free crops or by growing mosaic-resistant varieties. Control of insects is related to control of diseases because many insects spread diseases from plant to plant and from one field to another.

Rust and powdery mildew can be controlled by sulfur dust, provided the treatment is not delayed too long. This method of control is recommended only where one or both of these diseases occur with regularity and in severe form. Mild attacks of rust and mildew are apt to occur in any area, particularly in the fall. Mild attacks, however, do not justify sulfur treatment.

Root rot, stem rot, and web blight are so closely associated with weather conditions that they cannot be prevented entirely. Insurance of proper soil drainage and practice of a 4- or 5-year crop rotation will lessen the damage caused when conditions are otherwise favorable for these diseases.

In irrigated sections it is bad farming practice to use dead bean plants or bean straw to divert the flow of water to various places in the field or to prevent washing at the intakes or elsewhere. If such material is diseased, the running water affords an excellent means of carrying the disease organisms to nearly all the plants in the field. If bean straw or manure from bean straw is spread on fields, it is usually best to avoid placing it on fields to be planted to beans the next season.

SEED TREATMENT

Treatment of seed with various chemicals has been recommended and to some extent practiced as a means of disease control. The results have been too variable and uncertain to recommend as a general practice. The most beneficial results are likely to be obtained in very early plantings if the soil is wet and cold. Under such conditions the disinfectant may protect the seed from rotting until it has a chance to germinate. On the other hand, seed treatment is likely to be of little

value if the weather is sufficiently warm and otherwise favorable for quick germination.

INSECTS AND THEIR CONTROL ²

MEXICAN BEAN BEETLE

The Mexican bean beetle is a copper-colored beetle, spotted with 16 black marks. It has long been present in the Rocky Mountain region and is now generally distributed in the Eastern States. It destroys table beans of all kinds. The spiny, yellow, fuzzy-looking larvae feed on the under sides of the leaves and remove the lower surface of leaves but leave the upper surface intact.

The best control for the Mexican bean beetle is a spray containing ground derris, or cube, root.

Derris, or cube, powder having a rotenone content of 4 percent should be used at the strength of 1½ pounds in 50 gallons of water. Derris, or cube, powder of a different rotenone content should be used in proportion to that content so as to make a spray containing 0.015 percent of rotenone. Cryolite is also useful and should be used in the proportion of 3 pounds in 50 gallons of water. One to three, sometimes four, applications are required, depending on the abundance of the insect.

As important as thorough spraying is the destruction of the crop remains after harvest. Plow under all plant remnants at least 6 inches deep.

Dusting as a rule does not give as good results as spraying. A dust containing derris, or cube (4 percent rotenone), 12½ pounds, and talc, sulfur, clay, or other diluent, 87½ pounds, may be used. Pyrethrum dust containing 0.5 percent of total pyrethrins or an impregnated dust containing 0.3 percent total pyrethrins may be substituted for rotenone sprays or dust but is not quite so effective. During the present emergency it is recommended that these pyrethrum dusts be substituted for the dust mixtures containing rotenone or cryolite.

Arsenicals are liable to cause foliage injury and, if used, should be applied sparingly. Lead arsenate and paris green are particularly injurious to beans. **Fluorine compounds, such as cryolite, and arsenical insecticides are poisonous. Handle them carefully and avoid accidents. Cryolite and arsenicals should not be applied to beans after the pods begin to form.**

The bean beetle is not difficult to control if the insecticide is applied to the under sides of the leaves, where the destructive larvae feed. Applications to the top surfaces of leaves are a waste of time and material. One should watch for the first appearance of the beetles and begin control measures as soon as the first adults or egg masses are found. It will be too late to prevent appreciable damage if treatment is delayed until injured foliage is readily apparent in the beanfield.

BEAN LEAFHOPPER

The bean leafhopper is a very small green insect that feeds from the under sides of the bean leaves, sucking the juices from the tissues. During the feeding process it imparts to the plant a toxic substance

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that causes a curling of the leaves and stunting of the plant called hopperburn.

The bean leafhopper is controlled by sulfur dust at the rate of 15 to 20 pounds per acre per application, directed to the under sides of the leaves. The first application should be made at the time the first leafhoppers can be found, and 2 or 3 applications should be made at intervals of 6 or 7 days. If the infestation becomes severe, it is necessary to use a dust composed of 95 parts of sulfur and 5 parts of pyrethrum powder, containing approximately 1 percent of pyrethrins, at the rate of 20 pounds per acre.

SEED-CORN, OR BEAN, MAGGOT

The seed-corn, or bean, maggot attacks the germinating seed or the seedling in the soil. It may destroy the seed before the seedling can emerge, or it may only result in damaged and unproductive seedlings. This insect is especially destructive in cold, wet soils in the spring and in soils containing large quantities of nondecayed or partly decayed organic matter. There is no known method of control after infestation occurs; so preventive measures must always be taken against it.

Damage by the seed-corn maggot can best be avoided or minimized by careful attention to the following: (1) Plant beans only on soil in which green manure, cover crops, weeds, or sod has been turned under long enough to become well rotted. (2) Plant relatively shallow in warm, well-drained soil. (3) Avoid applying manure immediately before growing beans. (4) Avoid the use of commercial fertilizers high in organic constituents such as bonemeal, tankage, and fish scrap. (5) Avoid planting at a time the maggots are known to be abundant in the soil.